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(54) **LOW-OVERHEAD IMAGE SEARCH RESULT GENERATION**

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G06F 17/30 (2006.01)
G06K 9/62 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 17/30247*** (2013.01); ***G06F 17/3028*** (2013.01); ***G06K 9/6201*** (2013.01); *G06F 17/30244* (2013.01); *G06F 17/30867* (2013.01)

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CPC G06F 17/30256; G06F 17/30274; G06F 17/30244; G06F 17/3028
USPC 707/765, 749, 723, 706
See application file for complete search history.

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2011/0029510 A1 * 2/2011 Kroon et al. 707/723
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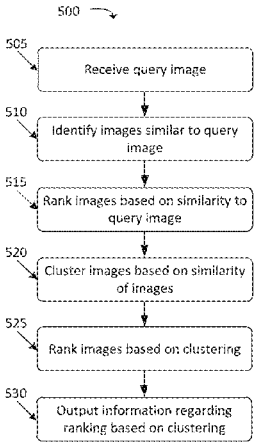
(57) **ABSTRACT**

A device may be configured to identify a plurality of images that are similar to a query image; generate a plurality of sets of rankings of the identified images based on a plurality of image attributes; compare the generated plurality of sets of rankings of the identified images to a reference set of rankings of images; select, based on the comparing, a particular set of rankings; and rank a plurality of images that are associated with another query image, based on an attribute associated with the selected particular set of rankings.

20 Claims, 13 Drawing Sheets



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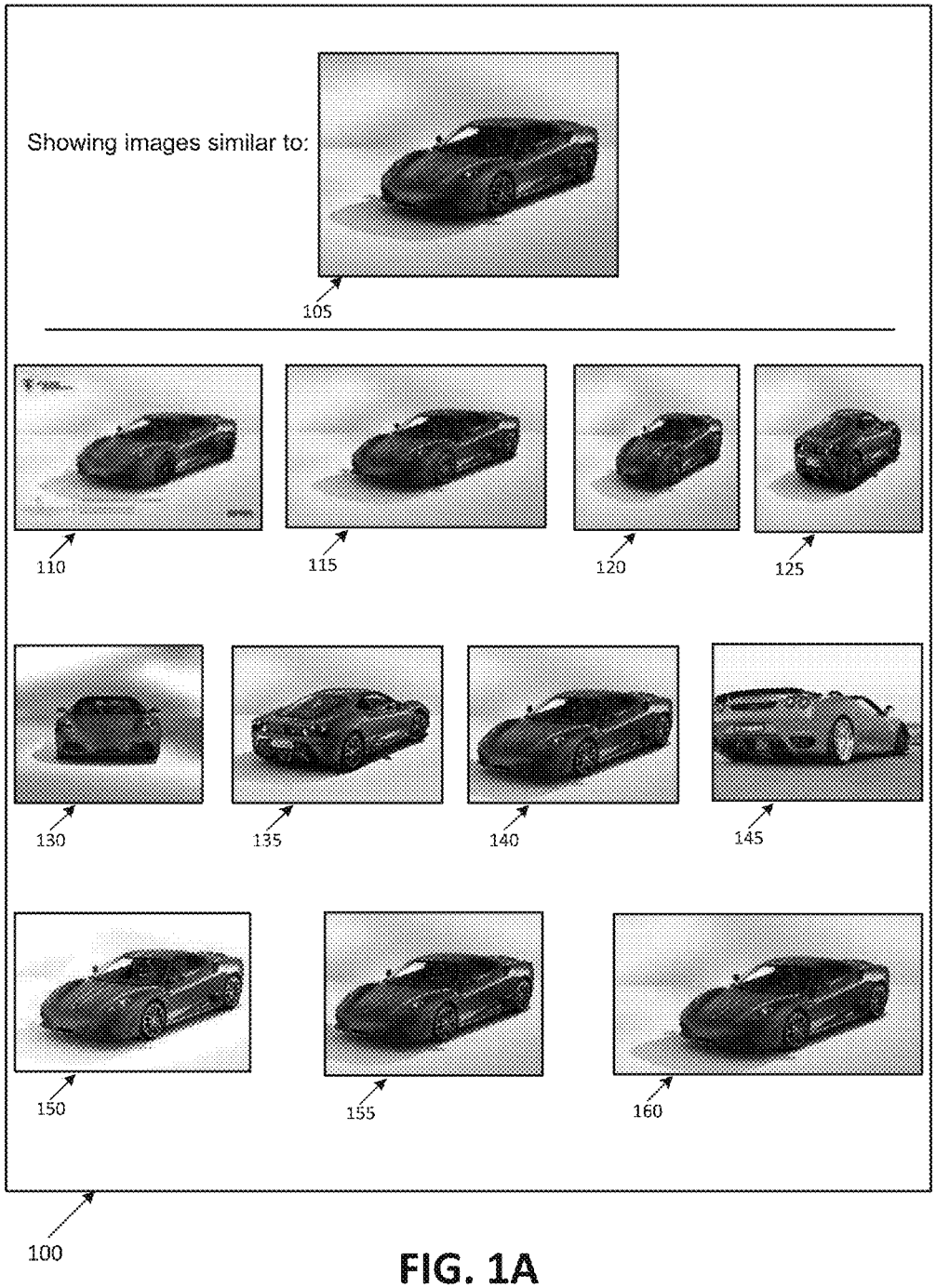
Showing images similar to:
105
110
115
120
125
130
135
140
145
150
155
160
100

FIG. 1A

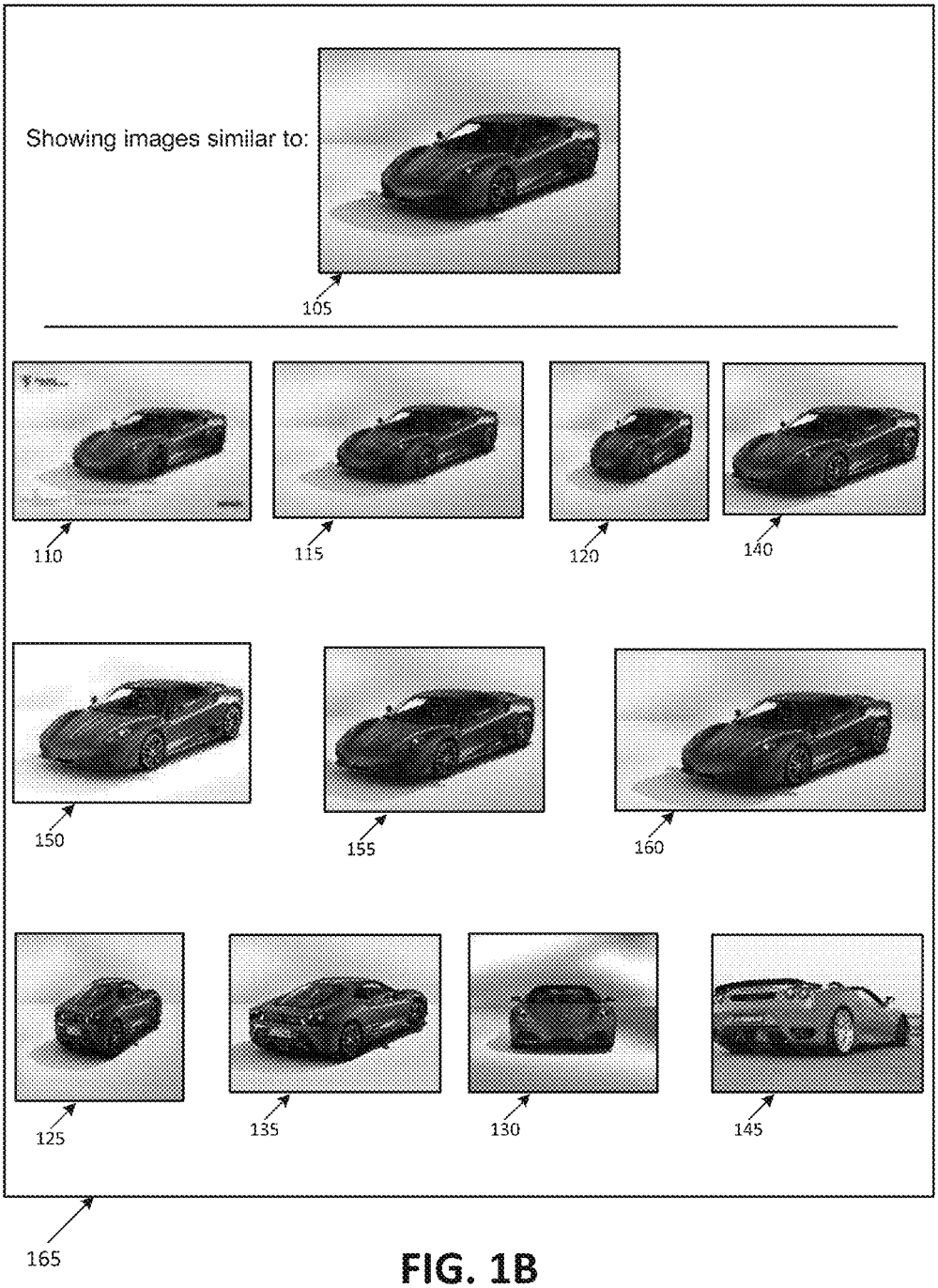
Showing images similar to:
105
110
115
120
140
150
155
160
125
135
130
145
165

FIG. 1B

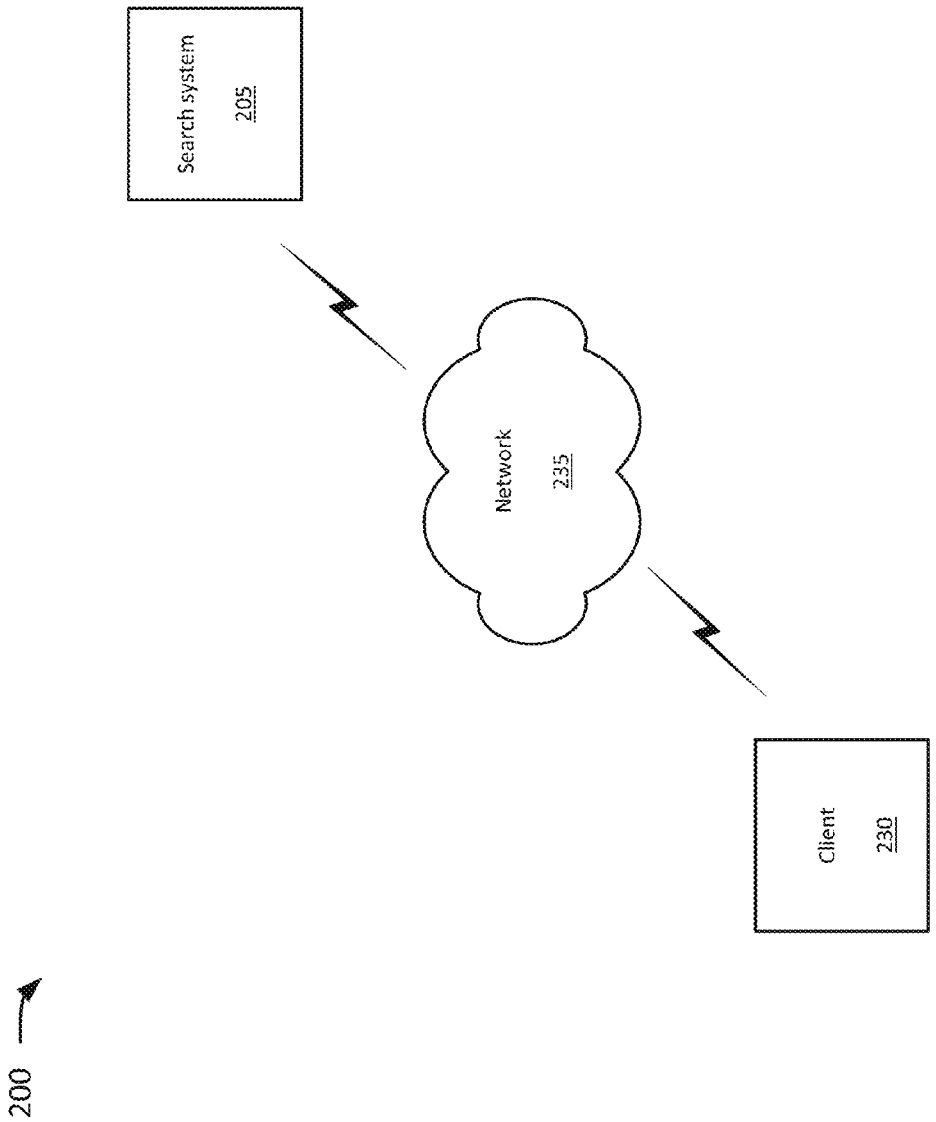

FIG. 2

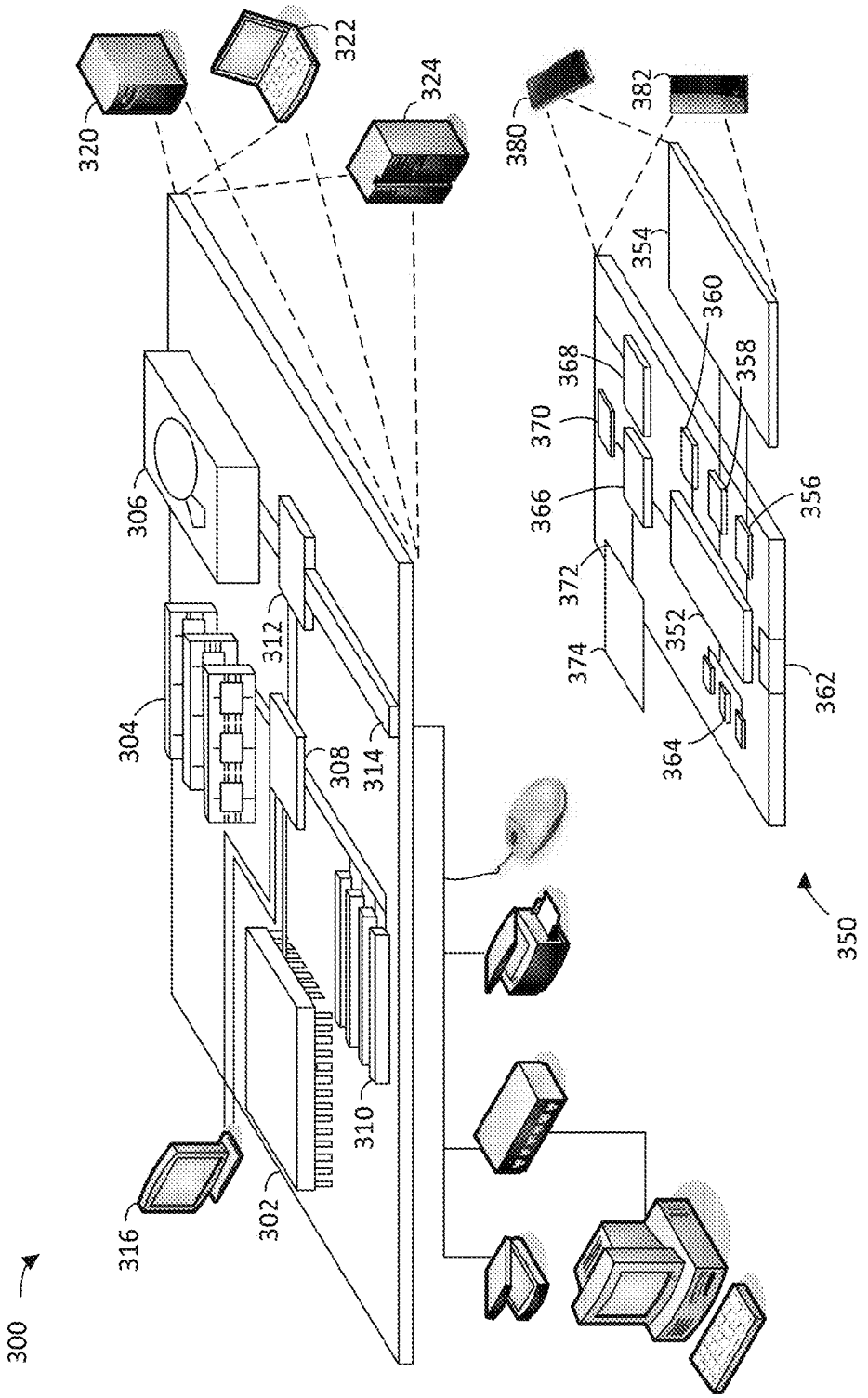
300
302
304
306
308
310
312
314
316
320
322
324
350
352
354
356
358
360
362
364
366
368
370
372
374
380
382

FIG. 3

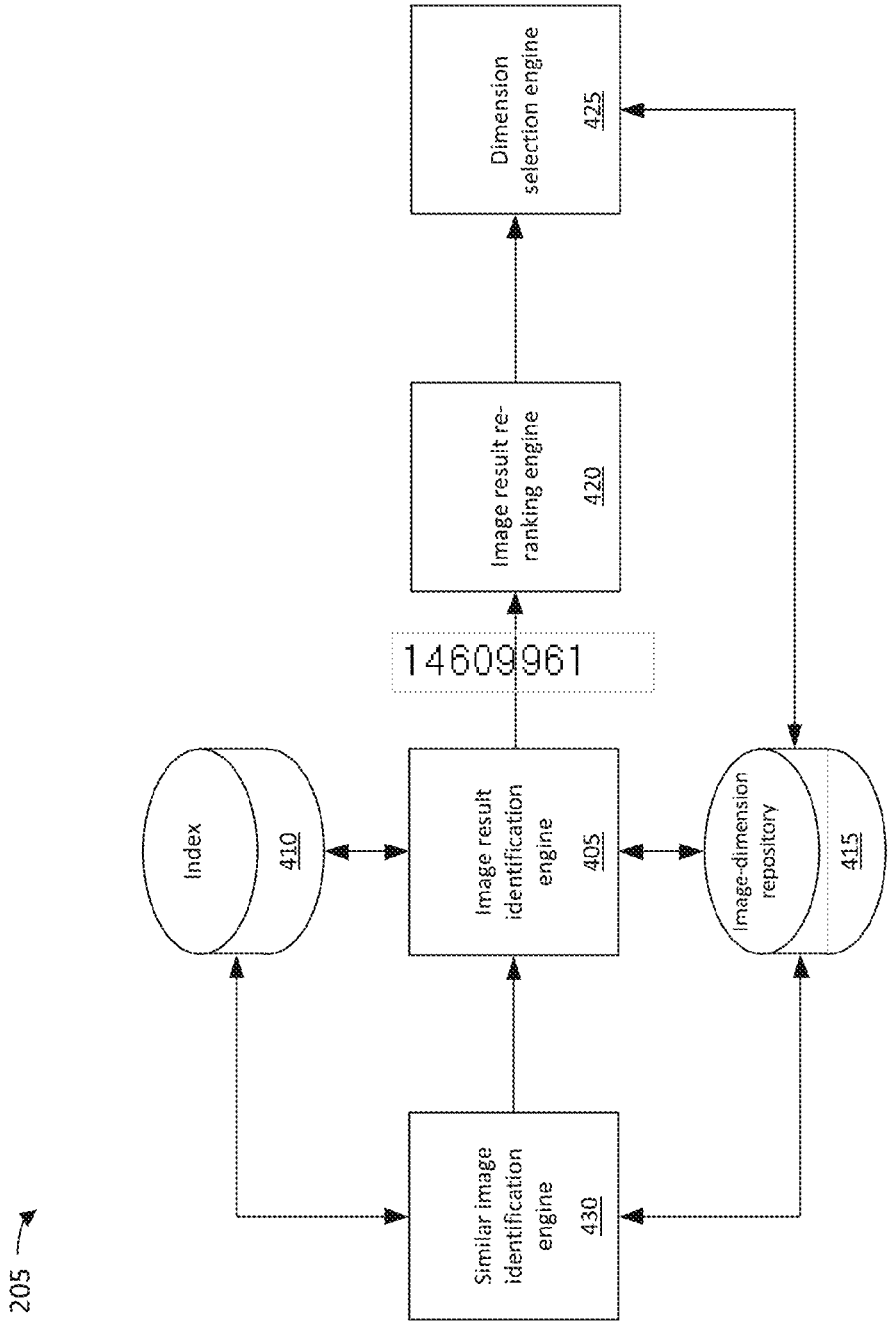
205
Similar image identification engine 430
Image result identification engine 405
Index 410
Image-dimension repository 415
14609961
Image result re-ranking engine 420
Dimension selection engine 425

FIG. 4

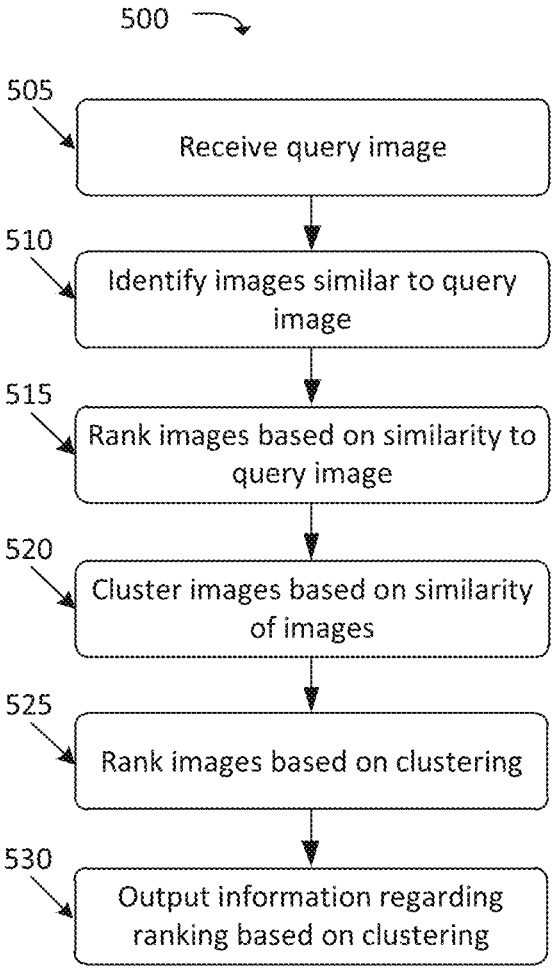
500
505
Receive query image
510
Identify images similar to query image
515
Rank images based on similarity to query image
520
Cluster images based on similarity of images
525
Rank images based on clustering
530
Output information regarding ranking based on clustering

FIG. 5

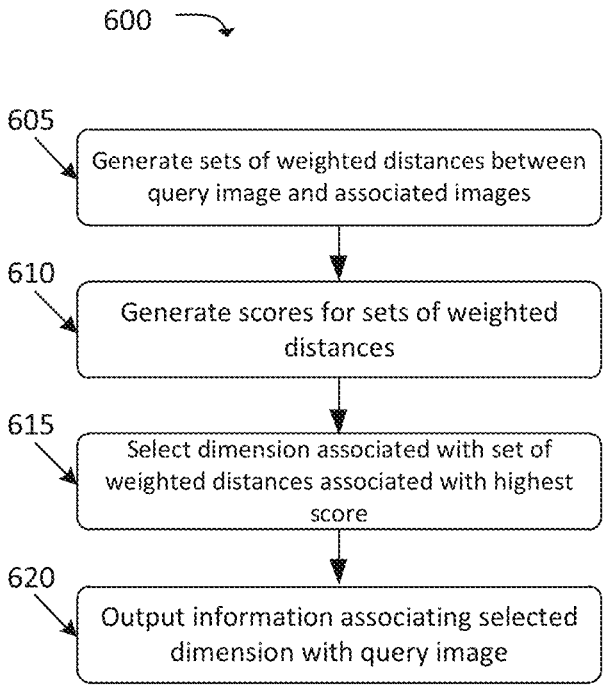
600
605
Generate sets of weighted distances between query image and associated images
610
Generate scores for sets of weighted distances
615
Select dimension associated with set of weighted distances associated with highest score
620
Output information associating selected dimension with query image

FIG. 6

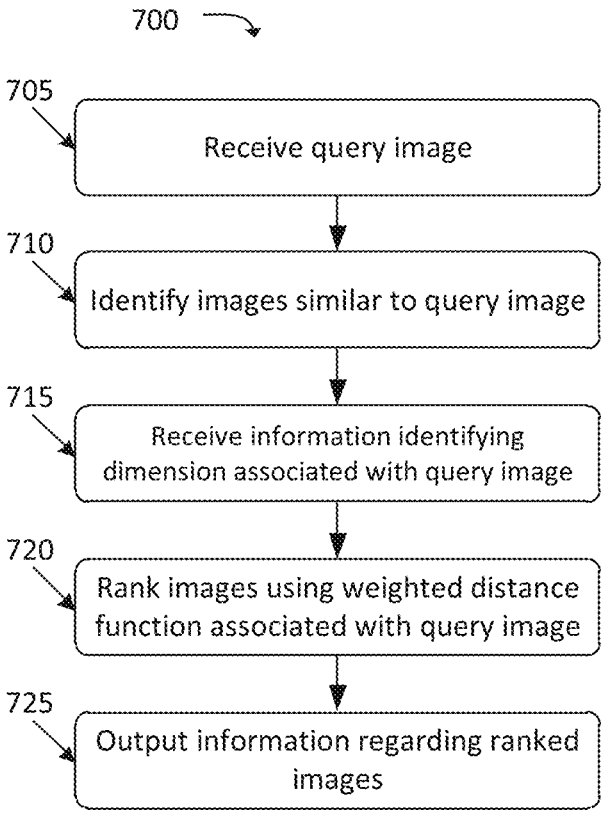
700
705
Receive query image
710
Identify images similar to query image
715
Receive information identifying dimension associated with query image
720
Rank images using weighted distance function associated with query image
725
Output information regarding ranked images

FIG. 7

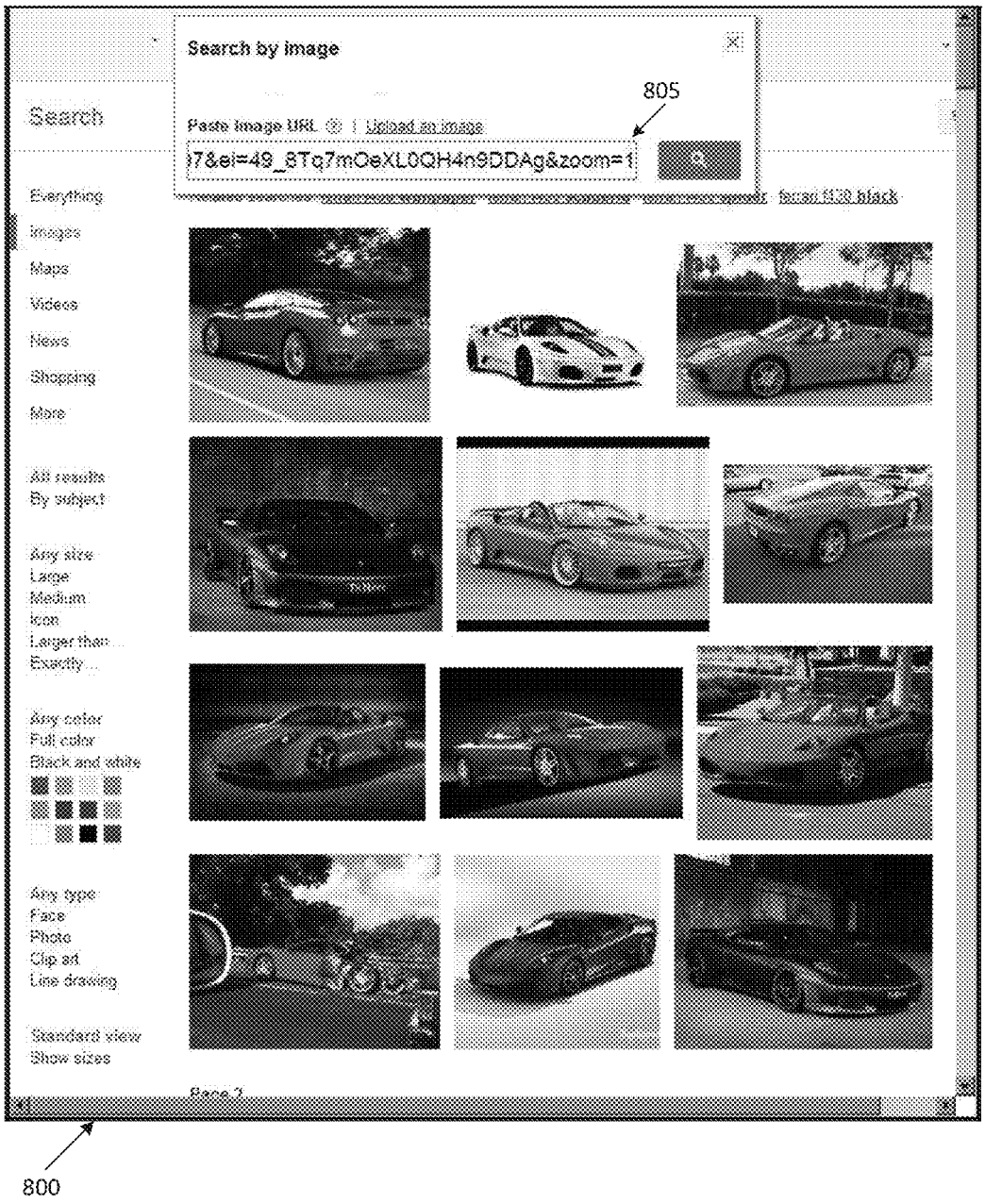
Search by image
805
Search
Paste image URL
Upload an image
Everything
Images
Maps
Videos
News
Shopping
More
All results
By subject
Any size
Large
Medium
Icon
Larger than
Exactly...
Any color
Full color
Black and white
Any type
Face
Photo
Clip art
Line drawing
Standard view
Show sizes
800

FIG. 8

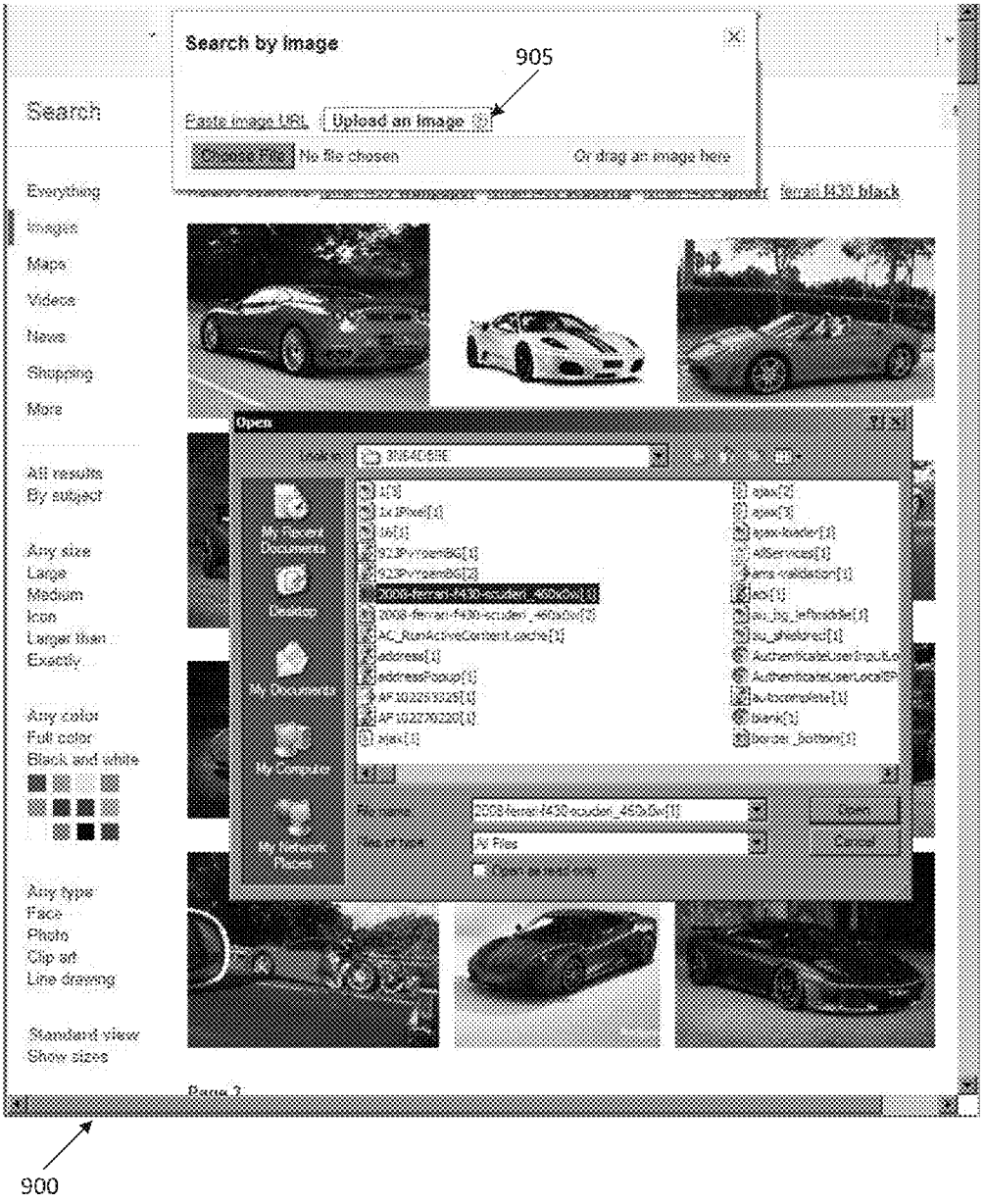
Search by image
905
Search
Paste image URL
Upload an image
No file chosen
Or drag an image here
Everything
Images
Maps
Videos
News
Shopping
More
All results
By subject
Any size
Large
Medium
Icon
Larger than
Exactly
Any color
Full color
Black and white
Any type
Face
Photo
Clip art
Line drawing
Standard view
Show sizes
Open
My Files
900

FIG. 9

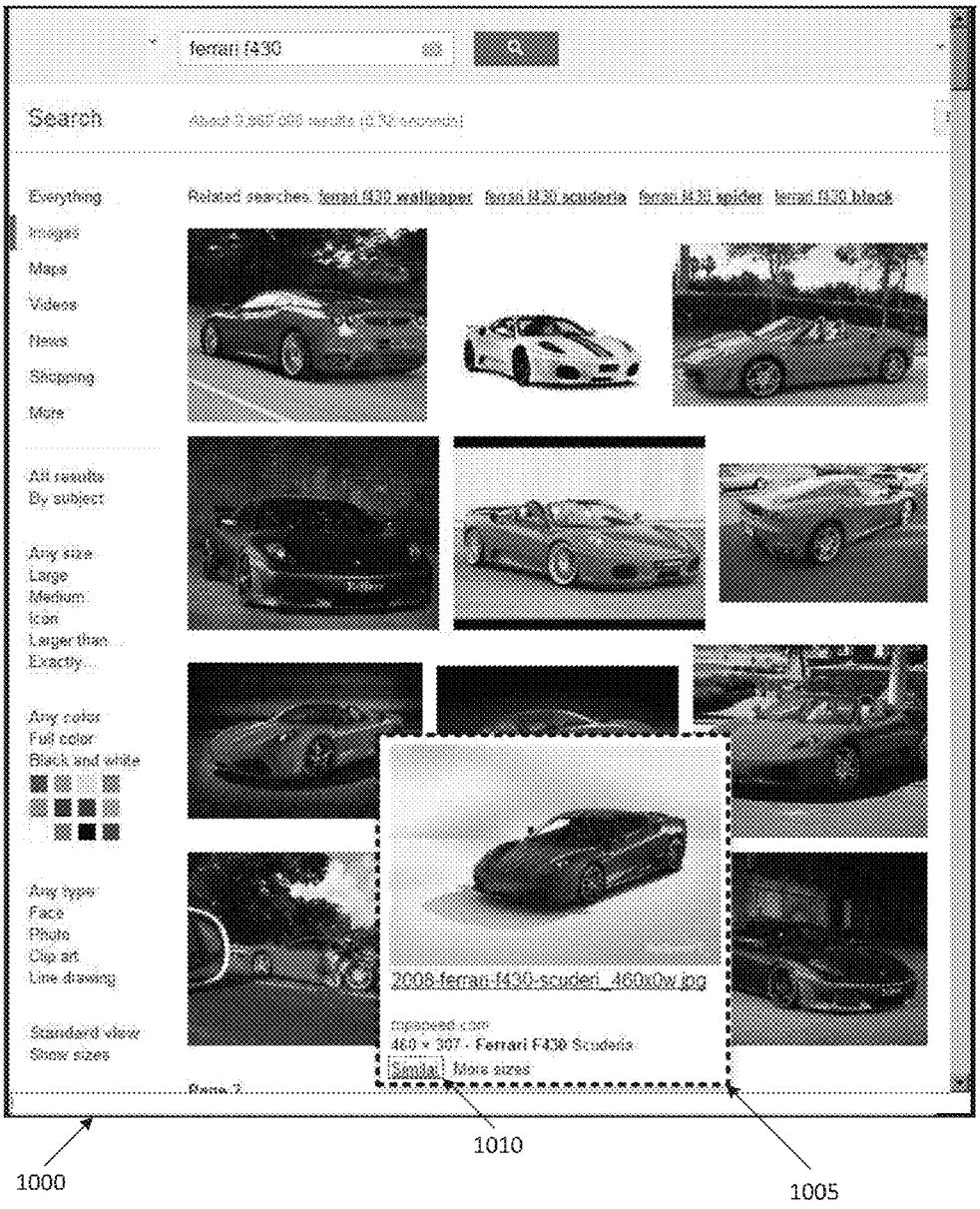
ferrari f430
Search
Everything
Images
Maps
Videos
News
Shopping
More
All results
By subject
Any size
Large
Medium
Icon
Larger than
Exactly...
Any color
Full color
Black and white
Any type
Face
Photo
Clip art
Line drawing
Standard view
Show sizes
Related searches: ferrari f430 wallpaper ferrari f430 scuderia ferrari f430 spider ferrari f430 black
2008-ferrari-f430-scuderi_460x0w.jpg
460 × 307 - Ferrari F430 Scuderia
Similar
More sizes
1000
1010
1005

FIG. 10

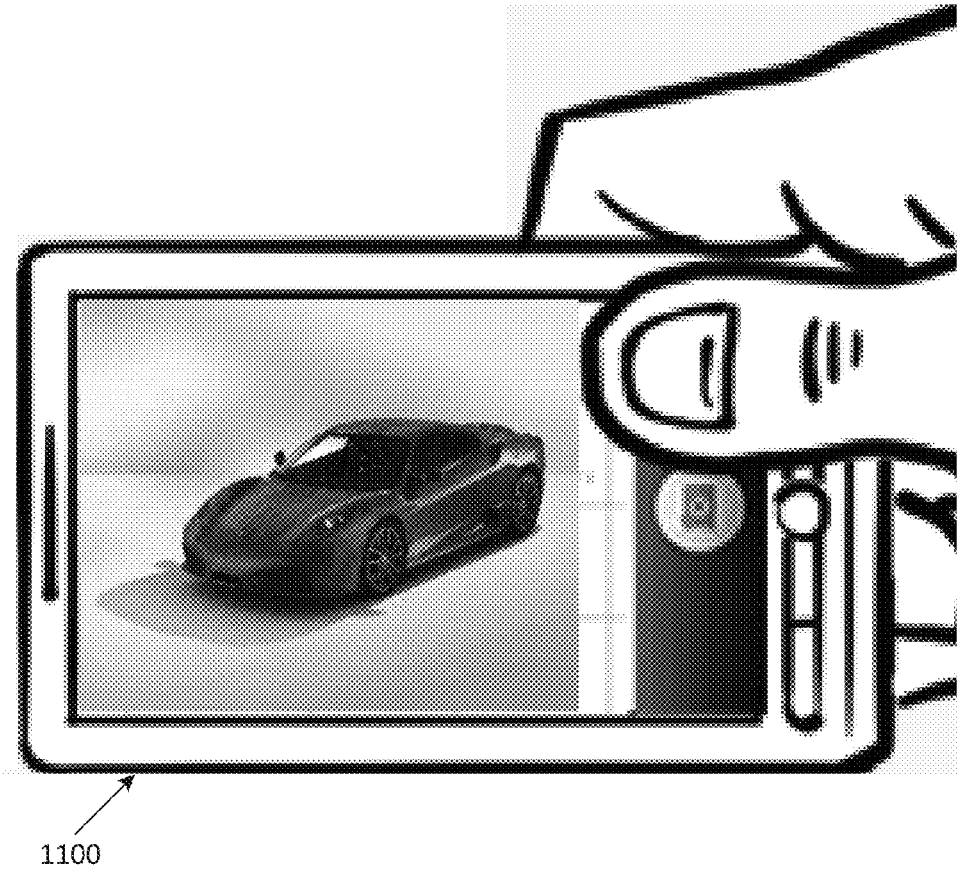

FIG. 11

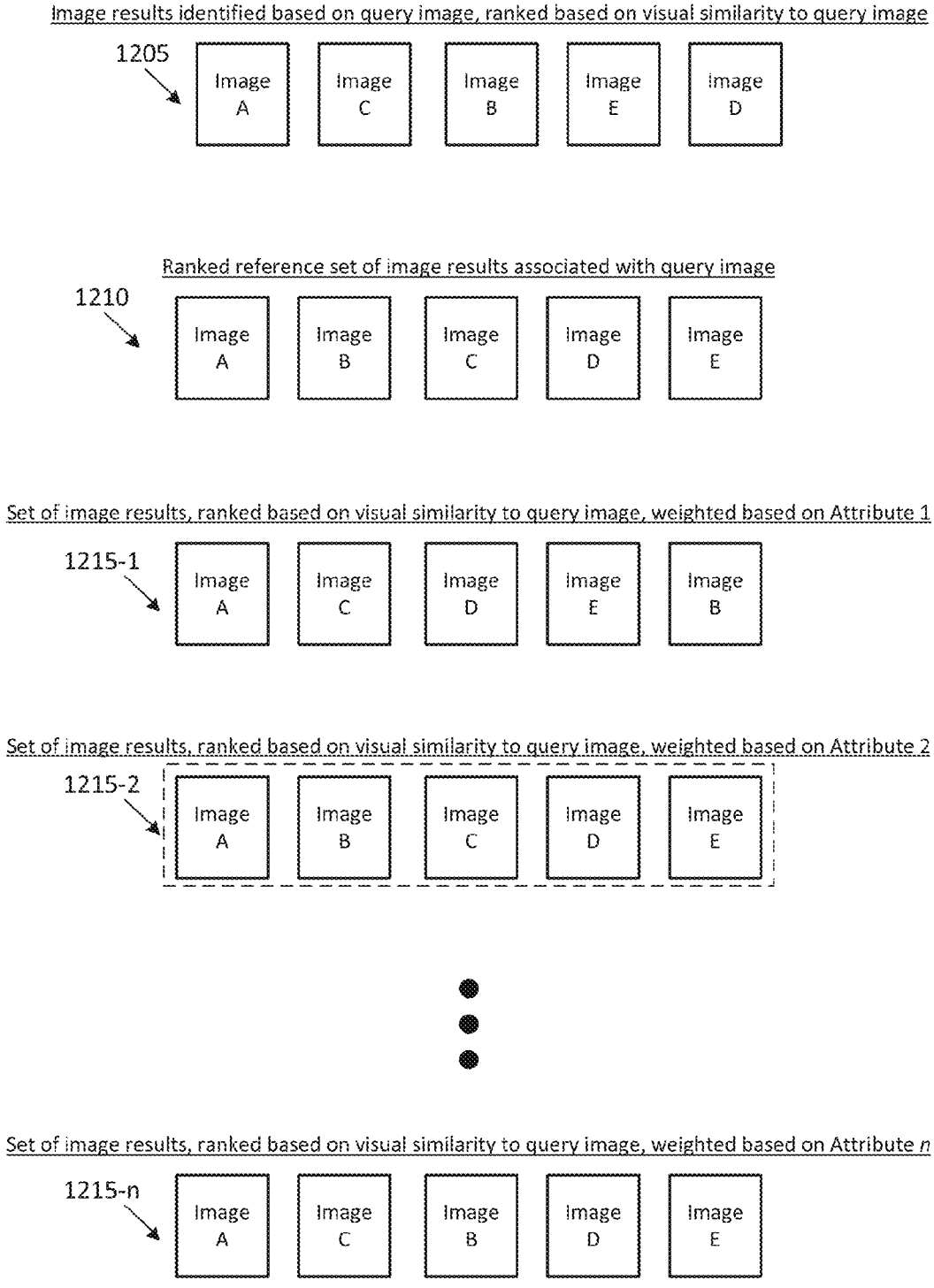
Image results identified based on query image, ranked based on visual similarity to query image
1205
Image A
Image C
Image B
Image E
Image D
Ranked reference set of image results associated with query image
1210
Image A
Image B
Image C
Image D
Image E
Set of image results, ranked based on visual similarity to query image, weighted based on Attribute 1
1215-1
Image A
Image C
Image D
Image E
Image B
Set of image results, ranked based on visual similarity to query image, weighted based on Attribute 2
1215-2
Image A
Image B
Image C
Image D
Image E
Set of image results, ranked based on visual similarity to query image, weighted based on Attribute n
1215-n
Image A
Image C
Image B
Image D
Image E

FIG. 12

LOW-OVERHEAD IMAGE SEARCH RESULT GENERATION

RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 13/480,240, filed May 24, 2012 (now U.S. Pat. No. 8,949,253), which is incorporated herein by reference.

BACKGROUND

The World Wide Web ("web") contains a vast amount of information. A search engine may assist a user in locating images, located on the web, that are similar to a query image.

Information retrieval systems, for example, Internet search engines, aim to identify resources, such as web pages, images, text documents, multimedia context, etc., that are relevant to a user's needs, and to present information about the resources in a manner that is most useful to the user. Internet search engines return a set of search results in response to a user submitted query. The search results identify resources responsive to a user's query. The identified resources can include varying types of content including documents, text, images, video, and audio.

In some information retrieval systems, a user can perform an image search. An image search is a search for image content responsive to an input query. An image can include a static graphic representative of some content, for example, photographs, drawings, computer generated graphics, advertisements, web content, book content. An image can also include a collection of image frames, for example, of a movie or a slideshow.

SUMMARY

According to some implementations, a method may include identifying a plurality of images that are similar to a query image; generating, by at least one of the one or more server devices, a plurality of sets of rankings of the identified images based on a plurality of image attributes; comparing, by at least one of the one or more server devices, the generated plurality of sets of rankings of the identified image results to a reference set of rankings of images; selecting, based on the comparing and by at least one of the one or more server devices, a particular set of rankings; and ranking, by at least one of the one or more server devices, a plurality of image results that are associated with another query image, based on an attribute associated with the selected particular set of rankings.

According to some implementations, selecting the particular set of rankings may include identifying that an order of image results in the particular set of rankings matches an order of images in the reference set more closely than orders of image results in the other sets of rankings, of the set of sets of rankings.

According to some implementations, the method may further include ranking the image results based on similarity of the image results to the first query image; grouping the image results, of the set of image results; and generating the reference ranking set by ranking the image results, of the set of image results, based on the grouping.

According to some implementations, grouping the image results may include identifying images, of the set of images, that are visually similar to each other, and grouping the images, of the set of images, that have been identified as being visually similar to each other.

According to some implementations, ranking the image results based on the grouping may include identifying, for each group, a similarity score based on a similarity of at least one image result in the group to the query image; ranking the image results based on similarity scores of respective groups associated with the image results.

According to some implementations, the other query image may be identical to the query image.

According to some implementations, the method may further include receiving a third query image; determining that the third query image is identical to or similar to the first query image; and storing information associating the particular attribute with the third query image based on determining that the third query image is identical to or similar to the first query image.

According to some implementations, a method may include receiving a first query image that is associated with a group of different attributes; receiving a first group of image results that are similar to the first query image; ranking the image results, of the first group of image results, based on similarity of the image results to the first query image; grouping the image results, of the first group of image results. The grouping may include identifying image results, of the first group of image results, that are visually similar to each other, and grouping image results, of the first group of image results, that have been identified as being visually similar to each other. The method may further include generating a reference ranking set by re-ranking the image results, of the first group of image results, based on the grouping; generating a group of ranked sets of image results. At least a particular one of the generated sets of image results may include the first group of image results, and each different set of image results may be ranked based on a different particular attribute of the group of different attributes. The method may also include comparing the group of ranked sets of image results to the reference ranking set; identifying a particular ranked set, of the group of ranked sets of image results, that has a ranking that is most similar to a ranking of the reference ranking set; identifying a particular attribute, based on which the particular ranked set is ranked; and ranking, based on the identified particular attribute, a second group of image results, based on receiving a second query image.

According to some implementations, ranking the image results of the second set of image results may include forgoing grouping the second set of image based on visual similarity.

According to some implementations, the method may further include storing information associating the query image with the particular attribute; and receiving, after storing the information, the second query image from a client device. The second query image may be a same image as the first query image. The method may further include receiving the second set of image results. The second set of image results may be similar to the second query image. The method may further include presenting, to the client device, information regarding the ranked image results, of the second set of image results.

According to some implementations, the method may further include receiving a third query image; determining that the third query image is identical to or similar to the first query image; and storing information associating the particular attribute with the third query image based on determining that the third query image is identical to or similar to the first query image.

According to some implementations, comparing the set of ranked sets of image results to the reference ranking set may include performing a Kendall's tau distance comparison

between each ranked set, of the set of ranked sets of image results, to the reference ranking set.

According to some implementations, ranking the second set of image results, based on the identified attribute, may include using a function, that more heavily weights the identified attribute than other attributes, to calculate a weighted distance between each image result, of the second set of image results, and the second query image; and ranking the second set of image results based on the calculated weighted distances.

According to some implementations, the set of attributes may include a first quantity of different attributes, the generated set of ranked sets of image results may include a second quantity of ranked sets of image results, and the first quantity and the second quantity may be equal.

The above discussion mentions examples in which some implementations may be implemented via one or more methods. In some implementations, one or more systems and/or devices may be configured to perform one or more of the acts mentioned above. In some implementations, a computer-readable medium may include computer-executable instructions which, when executed by one or more processors, cause the one or more processors to perform one or more of the acts mentioned above.

An image search engine, according to one or more implementations described herein, may continuously analyze a query image and images associated with the query image over time to determine which attributes of the images to more heavily weight. Using such a technique, the image search engine of some implementations may continuously learn which attribute and/or attributes of the images to more heavily weight, in order to continuously generate more relevant image result rankings for the query image.

Furthermore, by identifying one or more attributes of the query image, the image search engine of some implementations may efficiently identify the relevant image results by storing an indication of which attribute and/or attributes of the image results to more heavily weight. Thus, in lieu of storing vast amounts of data that indicate how to identify relevant image results for an image, the image search engine may store an indication of one or more attributes, and may generate the image results based on the one or more attributes. Additionally, using a ranking technique that more heavily weights the attribute and/or attributes may consume less time and/or processing resources than other techniques of ranking image results.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate one or more implementations described herein and, together with the description, explain these implementations. In the drawings:

FIGS. **1**A and **1**B illustrate an overview of an example implementation described herein;

FIG. **2** illustrates an example environment in which systems and/or methods described herein may be implemented;

FIG. **3** shows an example of a generic computer device and a generic mobile computer device according to one or more implementations;

FIG. **4** illustrates example functional components of a search system, according to one or more implementations described herein;

FIG. **5** illustrates a flowchart of an example process for ranking image search results based on clustering, according to one or more implementations described herein;

FIG. **6** illustrates a flowchart of an example process for storing information associating a dimension with a query image, according to one or more implementations described herein;

FIG. **7** illustrates a flowchart of an example process for presenting image results, ranked based on a weighted distance function associated with a query image, according to one or more implementations described herein;

FIGS. **8-11** illustrate examples of receiving a query image, according to one or more implementations described herein; and

FIG. **12** illustrates an example of selecting an attribute associated with a query image, according to one or more implementations described herein.

DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements.

A system and/or method, described herein, may enable one or more devices, such as one or more server devices implementing an image search engine, to present images that are visually similar to a query image. As described below, the image search engine may analyze the query image and image results, associated with the query image, to determine one or more attributes of the image results to more heavily weight, than other attributes of the image results, when ranking the image results associated with the query image.

FIGS. **1**A and **1**B are diagrams of example user interfaces that illustrate one or more implementations described herein. FIG. **1**A illustrates an example user interface **100**, which may be provided by a search engine. User interface **100** may be displayed at a client device via a browser. User interface **100** may include information regarding image search results that are similar to query image **105**. For example, user interface **100** may include thumbnail images that represent image search results **110-160**.

Each of image search results **110-160** may be ranked by the search engine based on one or more criteria, such as a similarity of each image search result to query image **105**; a similarity of each thumbnail image, corresponding to one of image search results **110-160**, to query image **105**; etc. As shown in FIG. **1**A, one or more of image search results **110-160** may not be ranked optimally. That is, one or more image search results **110-160**, which may be recognized by a user as being more visually similar to query image **105** than other image search results **110-160**, may be ranked lower than the other search results **110-160**.

For example, image search result **140** may be more visually similar to query image **105** than image search results **125-135**, but the search engine may have ranked image search result **140** below image search results **125-135**. Additionally, image search results **150-160** may be more visually similar to query image **105** than image search results **125-135** and **145**, but the search engine may have ranked image search result **140** below image search results **125-135** and **145**. Further still, image search result **135** may be more visually similar to query image **105** than image search result **130**, but the search engine may have ranked image search result **135** below image search result **130**.

FIG. **1**B illustrates example user interface **165**, which may be provided by a search engine according to one or more implementations described herein. User interface **165** may be displayed at a client device via a browser. User interface **165** may include information regarding image search results that

are similar to query image **105**. For example, user interface **165** may include thumbnail images that represent image search results **110-160**.

Query image **105**, shown in FIG. **1**B, may be the same as query image **105**, shown in FIG. **1**A. Additionally, image search results **110-160**, shown in FIG. **1**B, may be the same as image search results **110-160**, shown in FIG. **1**A. The ranking of image search results **110-160**, shown in FIG. **1**B, may be different than the ranking of image search results **110-160**, shown in FIG. **1**A. For example, in FIG. **1**B, image search results **110-120**, **140**, and **150-160** may be ranked higher than image search results **125-130** and **145**. Additionally, in FIG. **1**B, image search results **125** and **135** may be ranked higher than image search results **130** and **145**.

The ranking shown in FIG. **1**B may more closely match a ranking that is based on how visually similar a user may perceive a search image result to be to a query image, such as query image **105**. Additionally, search image results that are visually similar to each other may be consecutively ranked. For example, image search results **110-120**, **140**, and **150-160** may be consecutively ranked, as opposed to other image search results being ranked between image search results **110-120**, **140**, and **150-160**.

FIG. **2** is a diagram of an example environment **200** in which systems and/or methods described herein may be implemented. Environment **200** may include a server, such as search system **205**, and client **230** connected to network **235**. One search system **205** one client **230** have been illustrated as connected to network **235** for simplicity. In practice, environment **200** may include additional clients and/or servers or fewer clients and/or servers. Also, in some instances, a client may perform a function of a server, and a server may perform a function of a client.

Search system **210** may be implemented as a single server device or a collection of server devices that may be co-located or remotely located. Additionally, or alternatively, server **210** may be implemented within a single, common server device or a single, common collection of server devices.

Search system **210** may include server devices that gather, process, search, and/or implement functions in a manner described herein. For example, search system **210** may perform functions described with respect to one or more components described below with respect to FIG. **4**. Additional servers, implementing other functions may also be implemented in environment **200**. The additional servers may provide, for example, web content, payment services, shopping services, social networking services, etc.

Client **230** may include a client device, such as personal computer, a wireless telephone, a personal digital assistant ("PDA"), a tablet computer, a laptop, or another type of computation or communication device. Client **230** may include user interfaces, such as user interfaces **100** and/or **165**, presented through one or more browsers, e.g., web browsers.

Network **235** may include any type of network, such as a local area network ("LAN"), a wide area network ("WAN"), a telephone network—e.g., the Public Switched Telephone Network ("PSTN") or a cellular network—an intranet, the Internet, or a combination of networks. Search system **205** and client **230** may connect to network **235** via wired and/or wireless connections. In other words, any search system **205** and/or client **230** may connect to network **235** via a wired connection, a wireless connection, or a combination of a wired connection and a wireless connection.

FIG. **3** shows an example of a generic computing device **300** and a generic mobile computing device **350**, which may be used with the techniques described here. Generic computing device **300** and generic mobile computing device **350** may correspond to, for example, any of search system **205** and/or client **230**. Computing device **300** is intended to represent various forms of digital computers, such as laptops, desktops, workstations, personal digital assistants, servers, blade servers, mainframes, and other appropriate computers. Mobile computing device **350** is intended to represent various forms of mobile devices, such as personal digital assistants, cellular telephones, smart phones, and other similar computing devices. The components shown in FIG. **3**, their connections and relationships, and their functions, are meant to be examples only, and are not meant to limit implementations of the implementations described in this document.

Computing device **300** may include a processor **302**, memory **304**, a storage device **306**, a high-speed interface **308** connecting to memory **304** and high-speed expansion ports **310**, and a low speed interface **312** connecting to low speed bus **314** and storage device **306**. Each of the components **302**, **304**, **306**, **308**, **310**, and **312**, are interconnected using various busses, and may be mounted on a common motherboard or in other manners as appropriate. Processor **302** can process instructions for execution within the computing device **300**, including instructions stored in the memory **304** or on the storage device **306** to display graphical information for a graphical user interface ("GUI") on an external input/output device, such as display **316** coupled to high speed interface **308**. In other implementations, multiple processors and/or multiple buses may be used, as appropriate, along with multiple memories and types of memory. Also, multiple computing devices **300** may be connected, with each device providing portions of the necessary operations, e.g., as a server bank, a group of blade servers, or a multi-processor system, etc.

Memory **304** stores information within the computing device **300**. In some implementations, memory **304** includes a volatile memory unit or units. In another implementation, memory **304** includes a non-volatile memory unit or units. The memory **304** may also be another form of computer-readable medium, such as a magnetic or optical disk. A computer-readable medium may be defined as a non-transitory memory device. A memory device may include space within a single physical memory device or spread across multiple physical memory devices.

The storage device **306** is capable of providing mass storage for the computing device **300**. In some implementations, storage device **306** may be or may include a computer-readable medium, such as a floppy disk device, a hard disk device, an optical disk device, or a tape device, a flash memory or other similar solid state memory device, or an array of devices, including devices in a storage area network or other configurations. A computer program product can be tangibly embodied in an information carrier. The computer program product may also contain instructions that, when executed, perform one or more methods, such as those described herein. The information carrier is a computer or machine-readable medium, such as memory **304**, storage device **306**, or memory on processor **302**.

High speed controller **308** manages bandwidth-intensive operations for the computing device **300**, while low speed controller **312** manages lower bandwidth-intensive operations. Such allocation of functions is an example only. In some implementations, high-speed controller **308** is coupled to memory **304**, display **316**, e.g., through a graphics processor or accelerator, and to high-speed expansion ports **310**, which may accept various expansion cards. In this implementation, low-speed controller **312** is coupled to storage device **306** and low-speed expansion port **314**. The low-speed expan-

sion port, which may include various communication ports, e.g., USB, Bluetooth, Ethernet, wireless Ethernet, may be coupled to one or more input/output devices, such as a keyboard, a pointing device, a scanner, or a networking device such as a switch or router, e.g., through a network adapter.

Computing device **300** may be implemented in a number of different forms, as shown in the figure. For example, it may be implemented as a standard server **320**, or multiple times in a group of such servers. It may also be implemented as part of a rack server system **324**. In addition, it may be implemented in a personal computer such as a laptop computer **322**. Alternatively, components from computing device **300** may be combined with other components in a mobile device, such as mobile computing device **350**. Each of such devices may contain one or more of computing devices **300**, **350**, and an entire system may be made up of multiple computing devices **300**, **350** communicating with each other.

Mobile computing device **350** may include a processor **352**, memory **364**, an input/output ("I/O") device such as a display **354**, a communication interface **366**, and a transceiver **368**, among other components. Mobile computing device **350** may also be provided with a storage device, such as a microdrive or other device, to provide additional storage. Each of the components **350**, **352**, **364**, **354**, **366**, and **368** are interconnected using various buses, and several of the components may be mounted on a common motherboard or in other manners as appropriate.

Processor **352** can execute instructions within mobile computing device **350**, including instructions stored in memory **364**. Processor **352** may be implemented as a chipset of chips that include separate and multiple analog and digital processors. Processor **352** may provide, for example, for coordination of the other components of mobile computing device **350**, such as control of user interfaces, applications run by mobile computing device **350**, and wireless communication by mobile computing device **350**.

Processor **352** may communicate with a user through control interface **358** and display interface **356** coupled to a display **354**. Display **354** may be, for example, a TFT LCD (Thin-Film-Transistor Liquid Crystal Display) or an OLED (Organic Light Emitting Diode) display, or other appropriate display technology. Display interface **356** may include appropriate circuitry for driving display **354** to present graphical and other information to a user. Control interface **358** may receive commands from a user and convert them for submission to the processor **352**. In addition, an external interface **362** may be provide in communication with processor **352**, so as to enable near area communication of mobile computing device **350** with other devices. External interface **362** may provide, for example, for wired communication in some implementations, or for wireless communication in other implementations, and multiple interfaces may also be used.

Memory **364** stores information within mobile computing device **350**. Memory **364** can be implemented as one or more of a computer-readable medium or media, a volatile memory unit or units, or a non-volatile memory unit or units. Expansion memory **374** may also be provided and connected to mobile computing device **350** through expansion interface **372**, which may include, for example, a SIMM (Single In Line Memory Module) card interface. Such expansion memory **374** may provide extra storage space for device **350**, or may also store applications or other information for mobile computing device **350**. Specifically, expansion memory **374** may include instructions to carry out or supplement the processes described above, and may include secure information also. Thus, for example, expansion memory **374** may be provide as a security module for mobile computing device **350**, and may be programmed with instructions that permit secure use of device **350**. In addition, secure applications may be provided via the SIMM cards, along with additional information, such as placing identifying information on the SIMM card in a non-hackable manner.

Expansion memory **374** may include, for example, flash memory and/or NVRAM memory. In some implementations, a computer program product is tangibly embodied in an information carrier. The computer program product contains instructions that, when executed, perform one or more methods, such as those described above. The information carrier is a computer-or machine-readable medium, such as the memory **364**, expansion memory **374**, or memory on processor **352**, that may be received, for example, over transceiver **368** or external interface **362**.

Mobile computing device **350** may communicate wirelessly through communication interface **366**, which may include digital signal processing circuitry where necessary. Communication interface **366** may provide for communications under various modes or protocols, such as GSM voice calls, SMS, EMS, or MMS messaging, CDMA, TDMA, PDC, WCDMA, CDMA2000, or GPRS, among others. Such communication may occur, for example, through radio-frequency transceiver **368**. In addition, short-range communication may occur, such as using a Bluetooth, WiFi, or other such transceiver. In addition, GPS (Global Positioning System) receiver module **370** may provide additional navigation- and location-related wireless data to mobile computing device **350**, which may be used as appropriate by applications running on mobile computing device **350**.

Mobile computing device **350** may also communicate audibly using audio codec **360**, which may receive spoken information from a user and convert it to usable digital information. Audio codec **360** may likewise generate audible sound for a user, such as through a speaker, e.g., in a handset of mobile computing device **350**. Such sound may include sound from voice telephone calls, may include recorded sound, e.g., voice messages, music files, etc., and may also include sound generated by applications operating on mobile computing device **350**.

Mobile computing device **350** may be implemented in a number of different forms, as shown in the figure. For example, it may be implemented as a cellular telephone **380**. It may also be implemented as part of a smart phone **382**, personal digital assistant, or other similar mobile device.

Various implementations of the systems and techniques described herein can be realized in digital electronic circuitry, integrated circuitry, specially designed ASICs (application specific integrated circuits), computer hardware, firmware, software, and/or combinations thereof. These various implementations can include implementations in one or more computer programs that are executable and/or interpretable on a programmable system including at least one programmable processor, which may be special or general purpose, coupled to receive data and instructions from, and to transmit data and instructions to, a storage system, at least one input device, and at least one output device.

These computer programs, also known as programs, software, software applications or code, include machine instructions for a programmable processor, and can be implemented in a high-level procedural and/or object-oriented programming language, and/or in assembly/machine language. As used herein, the terms "machine-readable medium" and "computer-readable medium" refers to any non-transitory apparatus and/or device, e.g., magnetic discs, optical disks, memory, Programmable Logic Devices ("PLDs"), used to provide machine instructions and/or data to a programmable

processor, including a machine-readable medium that receives machine instructions as a machine-readable signal. The term "machine-readable signal" refers to any signal used to provide machine instructions and/or data to a programmable processor.

To provide for interaction with a user, the systems and techniques described herein can be implemented on a computer having a display device, e.g., a CRT (cathode ray tube) or LCD (liquid crystal display) monitor, for displaying information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and input from the user can be received in any form, including acoustic, speech, or tactile input.

The systems and techniques described herein can be implemented in a computing system that includes a back end component, e.g., as a data server, or that includes a middleware component, e.g., an application server, or that includes a front end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation of the systems and techniques described here, or any combination of such back end, middleware, or front end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a LAN, a WAN, and the Internet.

FIG. **4** illustrates example functional components of search system **205**, according to one or more implementations described herein. Search system **205** may include image result identification engine **405**, index **410**, image-dimension repository **415**, image result re-ranking engine **420**, and dimension selection engine **425**. In other implementations, search system **205** may include fewer components, additional components, or different components. Additionally, one or more components shown in FIG. **4** may perform the functions of one or more other components shown in FIG. **4**.

Image result identification engine **405** may receive a query image, e.g., from a client device. The query image may be, for example, an image file stored by the client device, captured via an input device, such as a camera, at the client device, etc. The query image may be uploaded by the client device, a link to the query image may be provided by the client device, etc. Additionally, or alternatively, the query image may be presented as an image result, and a user at the client may indicate that the user wishes to view more images similar to the query image.

Image result identification engine **405** may identify a set of image results based on the query image. The image results may include a set of images that are visually similar to the query image. As described further below, in some implementations, image result identification engine **405** may use one or more techniques to determine a respective similarity of each image result to the query image. As also described further below, image result identification engine **405** may rank the image results, based on the respective similarity of each image result, to the query image, using one or more techniques. In some implementations, search system **205** may use these image results to improve the ranking of image results. Additionally, or alternatively, search system **205** may provide these image results to a client, such as the client from which the query image was received.

Image result identification engine **405** may receive the image results from index **410**, which may store information regarding images, such as the images themselves and/or links to the images. The images, for which information is stored in index **410**, may be images that were identified, e.g., by a web crawler, as being included in documents, such as web pages, news articles, blogs, or the like. In some implementations, index **410** may store images in an original format. That is, index **410** may store the images in a format associated with the images, as identified by the web crawler. For example, if the web crawler identifies that a first image is associated with a first format, index **410** may store the first image in the first format. Further, if the web crawler identifies that a second image is associated with a different second format, index **410** may store the second image in the second format.

Additionally, or alternatively, index **410** may store the images in a different format than the original format associated with the images. That is, while the web crawler may identify that a particular image is associated with a first format, index **410** may store the particular image in a different second format in lieu of, or in addition to, storing the particular image in the first format. In some implementations, index **410** may generate the particular image in the second format by converting the particular image from the first format to the second format. In other implementations, another component may generate the particular image in the second format by converting the particular image from the first format to the second format.

As used above, a format of an image may refer to, for example, an image compression technique. Some image compression techniques may reduce the file size of an image file, without significantly and/or perceptibly impacting the visual representation of the image. Examples of image compression techniques may include Joint Photographic Experts Group ("JPEG"), Graphics Interchange Format ("GIF"), Portable Network Graphics ("PNG"), Tagged Image File Format ("TIFF"), WebP, or the like. An uncompressed image format may include, for example, an uncompressed bitmap image.

In some implementations, an image compression technique may fully represent an image as a set of values, also referred to as dimensions. Thus, one particular attribute of a compressed image may be a dimension of the image. One particular image compression technique may represent each image, compressed using the particular image compression technique, as a set of dimensions. The quantity of dimensions, produced using the particular image compression technique, may be the same from image to image. For example, a first image, generated using the particular image compression technique, may be represented as a set of 59 dimensions. A different second image, generated using the same particular image compression technique, may be represented as a different set of 59 dimensions.

Image-dimension repository **415** may store information associating a particular image with one or more dimensions. As described further below, image result identification engine **405** may receive the information associating the particular image with one or more dimensions, and may use this information when ranking the image results.

Image result re-ranking engine **420** may receive the image results from image result identification engine **405** and may re-rank the image results. In order to re-rank the image results, image result re-ranking engine **420** may form similarity clusters, and group the image results into similarity clusters. In order to form the similarity clusters, image result re-ranking engine **420** may use one or more clustering techniques, such as performing a pair-wise similarity comparison of each image result to each other image, performing spectral clustering, and/or hierarchical clustering. When comparing a particular image result to another particular image result,

image result re-ranking engine **420** may compare a distance of each dimension of the two image results. The distance may be a simple difference, a Euclidean distance, or any other type of distance.

For example, assume that the two image results each include 59 dimensions. In some implementations, image result re-ranking engine **420** may compare the distance between a first value, associated with a first dimension of the first image, and a second value, associated with the first dimension of the second image; image result re-ranking engine **420** may compare the distance between a third value, associated with a second dimension of the first image, and a fourth value, associated with the second dimension of the second image; and so on.

Referring to the image results shown in FIG. **1**A, image result re-ranking engine **420** may, for example, compare a similarity of image result **110** to each of image results **115-160**, may compare a similarity of image result **115** to each of image results **110** and **120-160**, and so on. Image result re-ranking engine **420** may form the clusters based on images that are within a particular threshold distance of each of each other. In other words, the formed clusters may include images that are similar to each other, within a particular similarity threshold. Continuing with this example, image result re-ranking engine **420** may form a first cluster that includes image results **110-120**, **140**, and **150-160**; a second cluster that includes image results **125** and **135**; a third cluster that includes image **130**; and a fourth cluster that includes image result **145**.

Image result re-ranking engine **420** may re-rank image results **110-160** using any ranking technique. For example, in some implementations, image result re-ranking engine **420** may rank the clusters based on one or more factors, such as a quantity of image results in each cluster, similarity of the image results in a cluster to the query image, highest ranking image result in the cluster, average ranking of results in the cluster, median ranking of results in the cluster, any combination of the above, etc. For example, image result re-ranking engine **420** may rank the clusters in the following order: first cluster that includes image results **110-120**, **140**, and **150-160**; second cluster that includes image results **125** and **135**; third cluster that includes image **130**; and fourth cluster that includes image result **145**. In such an implementation, image result re-ranking engine **420** may re-rank the image results based on the ranking of the respective cluster in which the image result is included.

Additionally, or alternatively, image result re-ranking engine may rank image results within clusters. For example, in some implementations, image result re-ranking engine may rank image results within clusters based on measure of a similarity between the image results and the query image. Thus, image result re-ranking engine may rank image results based on clusters associated with the image results and/or a measure of similarity between the image results and the query image. As shown in FIG. **1**B, image result re-ranking engine **420** may rank the example image results in the following order: **110**, **115**, **120**, **140**, **150**, **155**, **160**, **125**, **135**, **130**, and **145**.

Dimension selection engine **425** may analyze the re-ranked image results, ranked by image result re-ranking engine **420** **220**, in order to determine one or more dimensions associated with the query image. As described below, image result identification engine **405** may use the one or more dimensions when ranking image results. When analyzing the re-ranked image results, dimension selection engine **425** may generate a set of T distances between the query image and each image result, where T is a quantity of dimensions associated with an image compression format of the query image. Each set of distances, of the T sets of distances, may be based on a function that more heavily weights a particular dimension than other distances, in the T sets of distances, weight the particular dimension.

For example, the function for a particular distance, of the set of T distances, may be:

$$D_t(x_q,x_i)=d(x_q,x_i)+c*(x_{q,t}-x_{i,t})^2 \quad \text{Equation 1:}$$

In Equation 1, $D_t(x_q, x_i)$ may refer to the distance, weighting the dimension t, between a query image x_q and a particular image result x_i. Further, d may refer to a distance between the query image x_q and the particular image result x_i, c may refer to a constant, $x_{q,t}$ may refer to a value corresponding to the dimension t associated with the query image x_q, and $x_{i,t}$ may refer to a value corresponding to the dimension t associated with the particular image result x_i. Assuming i is the quantity of image results, each set of distances, in the T sets of distances, may include i distances. Thus, dimension selection engine **425** may generate i*T distances in total.

While the above function was provided as an example, dimension selection engine **425** may generate the distances using any other function, such as one of the following equations:

$$D_t(x_q,x_i)=x_{q,t}-x_{i,t} \quad \text{Equation 2:}$$

$$D_t(x_q,x_i)=c*(x_{q,t}-x_{i,t}) \quad \text{Equation 3:}$$

For each particular set of distances, dimension selection engine **425** may rank the image results according to the respective distances in the particular set of distances. Thus, dimension selection engine **425** may generate T sets of rankings of the image results based on the respective weighted distances of the image results from the query image, with each set of rankings more heavily weighting a different dimension.

Dimension selection engine **425** may compare the respective order of each of the T sets of rankings to the order of the re-ranked results received from image result re-ranking engine **420**, in order to determine which set of rankings, of the T sets of rankings, is closest to the re-ranked results received from image result re-ranking engine **420**. In some implementations, dimension selection engine **425** may use a Kendall's tau ("Kendall's τ") distance function to determine which set of rankings, of the T sets of rankings, is closest to the re-ranked results received from image result re-ranking engine **420**. For example, dimension selection engine **425** may use the Kendall's τ distance function between each set of rankings, of the T set of rankings, and the re-ranked results received from image result re-ranking engine **420**. In some implementations, the Kendall's τ distance function may be represented by the following equation:

$$\tau=(P-Q)/(P+Q) \quad \text{Equation 4:}$$

In Equation 4, τ may represent the distance between a particular set of rankings and the re-ranked results received from image result re-ranking engine **420**, P may represent the quantity of concordant pairs of rankings, and Q may represent the quantity of discordant pairs of rankings.

Dimension selection engine **425** may select a particular set of rankings, associated with the highest result of the Kendall's τ distance function between the T sets of rankings and the re-ranked results received from image result re-ranking engine **420**. In some implementations, dimension selection engine **425** may identify a dimension associated with the selected particular set of rankings Additionally, dimension

selection engine **425** may provide information associating the identified dimension with the query image to image-dimension repository **415**.

For example, in a scenario where the order of a particular set of rankings, of the T sets of rankings, is identical to the order of the re-ranked results received from image result re-ranking engine **420**, the Kendall's τ distance function may indicate that the distance between the particular set of rankings and the re-ranked results is a value that reflects that the order of the particular set of rankings is identical to the order of the re-ranked results, such as a value of 1, 100, or another value. In another scenario, where another particular set of rankings, of the T sets of rankings, is in a reverse order, compared to the order of the re-ranked results received from image result re-ranking engine **420**, the Kendall's τ distance function may indicate that the distance between the particular set of rankings and the re-ranked results received from image result re-ranking engine **420** is a value that reflects that the order of the particular set of rankings is the reverse of to the order of the re-ranked results, such as a value of 0.

In yet another scenario, assume that some results are ranked the same in a third set of rankings compared to the re-ranked results received from image result re-ranking engine **420**, while other results are ranked differently in the third set of rankings compared to the re-ranked results received from image result re-ranking engine **420**. In this scenario, the Kendall's τ distance function may indicate that the distance between the particular set of rankings and the re-ranked results received from image result re-ranking engine **420** is a value that is in between the values in the examples described above, such as a value of 0.4, 0.5, 0.6, 40, 50, 60, etc. While the above examples were described in the context of a Kendall's τ distance function, dimension selection engine **425** may determine a similarity between each set of rankings, of the T set of rankings, and the re-ranked results received from image result re-ranking engine **420** using any function that indicates the similarity.

Image result identification engine **405** may use the identified dimension in subsequent image searches when the same query image is received. For example, assume image result identification engine **405** receives a query image from a client. Image result identification engine **405** may receive an identification of a particular dimension from image-dimension repository **415**, and may also receive a set of image results from index **410**. Image result identification engine **405** may rank the image results, received from index **410**, using a function that weights the particular dimension more heavily than other dimensions. For example, image result identification engine **405** may rank the image results using one or more of Equations 1-3, and/or any other function that weights the particular dimension more heavily than other dimensions. Image result identification engine **405** may provide the ranked image results to the client from which the query image was received.

Additionally, or alternatively, image result identification engine **405** may provide the ranked image results to image result re-ranking engine **420** for further processing, as described above. In some implementations, image result identification engine **405** may provide the ranked image results to image result re-ranking engine **420** for further processing each time image result identification engine **405** ranks the image results. In other implementations, image result identification engine **405** may provide the ranked image results to image result re-ranking engine **420** for further processing every other time that image result identification engine **405** ranks the image results for the particular query image, every three times that image result identification engine **405** ranks the image results for the particular query image, every four times that image result identification engine **405** ranks the image results for the particular query image, etc. In yet another implementation, image result identification engine **405** may forgo providing these ranked images to image result re-ranking engine **420** for further processing.

By providing the image results to image result re-ranking engine **420** for further processing, search system **205** may further improve the ranking performed by image result identification engine **405**. For example, over time, dimension selection engine **425** may determine that a particular image is associated with a different dimension than previously identified by dimension selection engine **425**. Additionally, or alternatively, dimension selection engine **425** may determine that a particular image is associated with an additional dimension. In such a scenario, image result identification engine **405** may rank image results using a function that weights multiple dimensions more heavily than other dimensions.

Similar image identification engine **430** may receive an image from, for example, a client device, index **410**, and/or any other device. Similar image identification engine **430** may determine whether the received image is associated with a selected dimension. For example, similar image identification engine **430** may identify whether image-dimension repository **415** stores information associating the received image, an identical image, and/or a similar image with a dimension. In order to identify whether image-dimension repository **415** stores information associating the received image, an identical image, and/or a similar image with a dimension, image-dimension repository **415** may compare the received image to images for which information is stored in image-dimension repository **415**. Image-dimension repository **415** may perform this comparison using one or more image comparison techniques.

When identifying an identical or similar image, image-dimension repository **415** may identify a measure of similarity between the similar or identical image and the received image. In some implementations, image-dimension repository **415** may identify that the similar or identical image is similar or identical to the received image if the measure of similarity exceeds a similarity threshold. In some implementations, if image-dimension repository **415** stores information associating the received image, an identical image, or a similar image with a dimension, search system **205** may forgo subsequently processing the image—e.g., may forgo providing the image to image result identification engine **405** for processing by image result identification engine **405**, image result re-ranking engine **420**, and/or dimension selection engine **425**.

FIG. **5** illustrates a flowchart of an example process **500** for ranking image search results based on clustering. In some implementations, process **500** may be performed by search system **205**. In another implementation, process **500** may be performed by one or more other components instead of, or possibly in conjunction with, search system **205**.

Process **500** may include receiving a query image (block **505**). For example, as described above with respect to image result identification engine **405**, search system **205** may receive a query image from a client, such as client **230**. FIGS. **8-11**, described below, illustrate examples of receiving a query image, according to one or more implementations.

Process **500** may also include identifying images that are similar to the query image (block **510**). For example, as discussed above with respect to image result identification engine **405**, search system **205** may identify a set of image results that are similar to the query image. The image results

may be a particular quantity of the most similar images to the query image. For example, the image results may be the 100 most similar images, the 1,000 most similar images, etc.

Process **500** may further include ranking the images based on similarity to the query image (block **515**). Continuing with the above example, search system **205** may rank the image results using any ranking technique to rank the image results based on similarity to the query image. Search system **205** may, for example, rank the image results based on a distance function that is based on some or all of the dimensions associated with the image results and/or the query image. Additionally, or alternatively, search system **205** may rank the image results, based on similarity to the query image, using a distance function that weights one or more dimensions more heavily than one or more other functions.

Process **500** may additionally include clustering the images based on similarity of the image results to each other (block **520**). Continuing with the above example, and as discussed above with respect to image result re-ranking engine **420**, search system **205** may generate one or more clusters, based on a similarity of the image results to each other. For instance, as discussed above, search system **205** may perform pair-wise distance comparisons of the image results in order to identify image results that are within a particular distance of each other. In some implementation, search system **205** may cluster the image results that are within the particular distance of each other.

Process **500** may also include ranking the images based on the clustering (block **525**). Continuing with the above example, and as discussed above with respect to image result re-ranking engine **420**, search system **205** may re-rank image the image results using any ranking technique. For example, as also discussed above, search system **205** may rank the image results within the clusters, and/or may rank the clusters. Search system **205** may re-rank the image results based on the ranks of the image results within the clusters, and/or based on the ranks of the respective clusters.

Process **500** may further include outputting information regarding the ranking based on the clustering (block **530**). Continuing with the above example, and as discussed above with respect to image result re-ranking engine **420**, search system **205** may provide information regarding the re-ranked image results to one or more other components. Additionally, or alternatively, search system **205** may provide information regarding the re-ranked image results to a client, such as client **230**, from which the query image was received.

FIG. **6** illustrates a flowchart of an example process **600** for storing information associating a dimension with a query image. In some implementations, process **600** may be performed by search system **205**. In another implementation, process **600** may be performed by one or more other components instead of, or possibly in conjunction with, search system **205**.

Process **600** may include generating sets of weighted distances between a query image and associated images (block **605**). For example, as discussed above with respect to dimension selection engine **425**, search system **205** may generate T sets of weighted distances between a query image and image results—e.g., one or more image results identified at block **510**. In some implementations, each set, of the T sets of weighted distances, may be weighted based on a particular dimension, of T dimensions. As also discussed above, to generate the T sets of weighted distances, search system **205** may use one or more of Equations 1-3, and/or any other function that weights a particular dimension higher than other dimensions when generating distances.

Process **600** may also include generating scores for the sets of weighted distances (block **610**). For example, as also discussed above with respect to dimension selection engine **425**, search system **205** may generate a score one or more of the sets of weighted distances generated at block **605**, using a function that compares an order of each set of weighted distances to an order of a re-ranked set of image results, such as the re-ranked set of image results identified at block **525**. In one example, as discussed above, the score for a particular set of weighted distances may be generated using a Kendall's τ distance function. Additionally, or alternatively, the score for the particular set of weighted distances may be generated using any function that compares an order of the particular set of weighted distances to the order of the re-ranked set of image results.

In some implementations, the highest score, out of the generated scores, for the set of weighted distances may correspond to an order of image results that is closest to the order of the re-ranked set of image results. In some implementations, search system **205** may generate a score for each set of weighted distances, while in other implementations, search system **205** may generate scores for fewer than all of the sets of weighted distances.

Process **600** may further include selecting a dimension associated with a set of weighted distances associated with the highest score (block **615**). For example, as further discussed above with respect to dimension selection engine **425**, search system **205** may determine which dimension, of the T dimensions, is associated with the set of weighted distances with the highest score. Additionally, or alternatively, search system **205** may determine a particular quantity of dimensions associated with a set of the highest scores. For example, search system **205** may identify the top two scores, the top three scores, etc., and select the dimensions associated with the identified scores.

Additionally, or alternatively, search system **205** may identify a quantity of scores that are within a particular distance from the top score. For example, assume that the particular distance is 10, and that search system **205** has identified scores of 100, 99, 91, 82, and 85. In this example, search system **205** may select the dimensions associated with the scores of 100, 99, and 91.

Process **600** may further include outputting information associating the selected dimension(s) with the query image (block **620**). For example, search system **205** may output the information associating the selected dimension(s) with the query image to a repository, such as search system **205**. As discussed further below, this information may be used in subsequent image searches.

In some implementations, as discussed above with respect to similar image identification engine **430**, search system **205** may forgo performing some or all of process **600** in some scenarios. For example, as described above, search system **205** may identify that a dimension has been previously selected for a query image and/or an identical or similar image. Search system **205** may select the previously selected dimension for the query image, and may output information associating the selected dimension with the query image.

FIG. **7** illustrates a flowchart of an example process **700** for presenting image results, ranked based on a weighted distance function associated with a query image. In some implementations, process **700** may be performed by search system **205**. In another implementation, process **700** may be performed by one or more other components instead of, or possibly in conjunction with, search system **205**.

Process **700** may include receiving a query image (block **705**). For example, as described above with respect to image

result identification engine **405**, sever **305** may receive a query image from a client, such as client **230**. Process **700** may also include identifying images results that are similar to the query image (block **710**). For example, as further discussed above with respect to image result identification engine **405**, search system **205** may identify a set of image results that are similar to the query image. The image results may be a particular quantity of the most similar images, stored by search system **205**, to the query image. For example, the image results may be the 100 most similar images, the 1,000 most similar images, etc.

In some implementations, the image results may be the same format as the query image. In such implementations, the image results may be compressed using a compression technique that represents the image results using the same quantity of dimensions as a compression technique that represents the query image.

Process **700** may also include receiving information identifying a dimension associated with the query image (block **715**). For example, search system **205** may receive the information identifying the dimension associated with the query image from search system **205**. Additionally, or alternatively, search system **205** may receive information identifying more than one dimension associated with the query image from search system **205**.

Process **700** may further include ranking the images using a weighted distance function associated with the query image (block **720**). Continuing with the above example, search system **205** may use one or more of Equations 1-3, and/or any other function that weights a particular dimension more heavily than other dimensions, to rank the image results.

While examples are provided above with respect to Equations 1-3, other functions may be used when search system **205** receives information identifying multiple dimensions. For example, search system **205** may use one or more of the following equations:

$$D_{t1,2}(x_q,x_i)=d(x_q,x_i)+c*(x_{q,t1}-x_{i,t1})^2+e*(x_{q,t2}-x_{i,t2})^2 \quad \text{Equation 5:}$$

$$D_{t1,2}(x_q,x_i)=x_{q,t1}-x_{i,t1}+x_{q,t2}-x_{i,t2} \quad \text{Equation 6:}$$

$$D_{t1,2}(x_q,x_i)=c*(x_{q,t1}-x_{i,t1})+e*(x_{q,t2}-x_{i,t2}) \quad \text{Equation 7:}$$

In the above example equations, $D_{t1,2}(x_q, x_i)$ may represent the distance, weighting the dimensions **t1** and **t2**, between a query image x_q and a particular image result x_i. Further, e may refer to a constant, $x_{q,t1}$ may refer to a value corresponding to the dimension **t1** associated with the query image x_q, $x_{i,t1}$ may refer to a value corresponding to the dimension **t1** associated with the particular image result x_i, $x_{q,t2}$ may refer to a value corresponding to the dimension **t2** associated with the query image x_q, and $x_{i,t2}$ may refer to a value corresponding to the dimension **t2** associated with the particular image result x_i. In some implementations, c and e may represent different values. In another implementation, c and e may represent the same values.

Process **700** may additionally include outputting information regarding the ranked images (block **725**). Continuing with the above example, search system **205** may provide information regarding the ranked image results to client **230**, from which the query image was received. Client **230** may present information regarding some, or all, of the image results via a web browser.

An implementation, described herein, may allow an image search engine to provide image search results that are similar to image search results provided via a clustering and re-ranking technique, without the need for performing clustering and re-ranking in response to receiving a query image. Additionally, the image search engine, of some implementations, may store a relatively small amount of information, which may enable the image search engine to provide the image search results. For example, in an example according to one or more implementations described above, assume that a particular query image is associated with 59 dimensions. The image search engine may store a 6-bit value that identifies a particular dimension, of the 59 dimensions, to weight more heavily when ranking image results.

Furthermore, the image search engine may continuously analyze the query image and associated image results over time to determine which dimension(s) of the image results to more heavily weight. In this sense, the image search engine may continuously learn which dimension(s) of the image results to use, in order to continuously generate more relevant image result rankings for the query image.

FIGS. **8-11** illustrate examples of receiving a query image. For example, a query image may be received at block **505** of FIG. **5**, and/or at block **705** of FIG. **7**. As shown in FIG. **8**, a client, such as client **230**, may present user interface **800**. User interface **800** may include option **805**, which allows a user to provide a location identifier, such as a uniform resource locator ("URL"), a uniform resource identifier ("URI"), or some other location identifier, that is associated with a query image.

Additionally, or alternatively, a client, such as client **230**, may present user interface **900**, as shown in FIG. **9**. User interface **900** may include option **905**, which allows a user to upload a query image. The query image may be stored locally at client **230**.

Additionally, or alternatively, a client, such as client **230**, may present user interface **1000**, as shown in FIG. **10**. User interface **1000** may display a set of image results, including image result **1005**. User interface **1000** may include option **1010**, which allows a user to view images that are visually similar to image result **1005**.

Additionally, or alternatively, as shown in FIG. **11**, a client, such as client **230**, may allow a user to capture an image via an image capture device associated with client **230**. In some implementations, client **230** may include cellular telephone **1100**, which may include a camera. Cellular telephone **1100** may allow a user to capture an image via the camera, and search for a visually similar image.

Once a query image is received, e.g., via one or more of the techniques illustrated in FIGS. **8-11**, an image search engine may provide a user interface that displays visually similar results. For example, the image search engine may provide user interface **165** in response to receiving a query image via one or more of the techniques illustrated in FIGS. **8-11**. The image results displayed in user interface **165** may be ranked according to one or more of the techniques described above—e.g., according to one or more of the processes illustrated in FIGS. **5-7**.

FIG. **12** illustrates an example of selecting an attribute associated with a query image. For example, assume that search system **205** receives a particular query image. Search system **205** may identify a set of image results **1205**, e.g., at block **510** of FIG. **5**. This set of image results **1205** may be ranked based on visual similarity of the image results to the query image, e.g., at block **515** of FIG. **5**. Search system **205** may also identify a ranked reference set of image results **1210**, which may be associated with the query image—e.g., re-ranked image results generated at block **525** of FIG. **5**. As shown in FIG. **12**, image results in reference set **1210** may be ordered differently than image results in the set of image results **1205** that are identified based on the query image. Such a situation may occur when images in reference set **1210**

are ranked in a manner that is more accurate and/or more desirable than the ranking in set **1205**.

Search system **205** may also generate multiple sets of rankings **1215-1** through **1215-*n*** of the image results, based on weighting different attributes, such as attributes **1-*n***. As described above, weighting a particular attribute may include assigning a particular weight to the attribute when determining a distance between the image results and the query image. As also described above, weighting different attributes may yield different sets of rankings, as shown in FIG. **12**. In the example shown in FIG. **12**, set of rankings **1215-2**, weighted based on "Attribute **2**," may be a closest set of rankings to reference set of rankings **1210**. That is, the order of the image results in set of rankings **1215-2** may be a closest order to the order of image results in reference set of rankings **1210**, out of sets of rankings **1215-1** through **1215-*n***. Thus, in some implementations, search system **205** may identify that "Attribute **2**" is associated with the query image. Search system **205** may thus weight image results using "Attribute **2**" when processing queries based on the query image. By doing so, search system **205** may provide more accurate image result rankings, while saving processing time compared to other techniques.

The foregoing description provides illustration and description, but is not intended to be exhaustive or to limit the implementations to the precise form disclosed. Modifications and variations are possible in light of the above description or may be acquired from practice of the implementations. For example, while series of blocks have been described with regard to FIGS. **5-7**, the order of the blocks may be modified in other implementations. Further, non-dependent blocks may be performed in parallel. Additionally, while dimensions were discussed above as one example of an attribute of an image that may be analyzed and/or weighted, other attributes may be analyzed and/or weighted in practice.

It will be apparent that systems and methods, as described above, may be implemented in many different forms of software, firmware, and hardware in the implementations illustrated in the figures. The actual software code or specialized control hardware used to implement these systems and methods is not limiting of the implementations. Thus, the operation and behavior of the systems and methods were described without reference to the specific software code—it being understood that software and control hardware can be designed to implement the systems and methods based on the description herein.

Even though particular combinations of features are recited and/or disclosed in the specification, these combinations are not intended to limit the disclosure of the possible implementations. In fact, many of these features may be combined in ways not specifically recited and/or disclosed in the specification.

No element, act, or instruction used in the present application should be construed as critical or essential unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items. Where only one item is intended, the term "one" or similar language is used. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

What is claimed is:

1. A method comprising:

generating, by a device and based on a first plurality of images grouped into a plurality of clusters, a ranking of the first plurality of images,

each cluster, of the plurality of clusters, including at least one of the first plurality of images, and

the ranking of the first plurality of images being based on a respective image attribute associated with each image, of the first plurality of images, in each cluster of the plurality of clusters;

comparing, by the device, the ranking with a set of rankings of images;

selecting, by the device and based on the comparing, a particular set of rankings from the set of the rankings of the images; and

providing, by the device and for presentation, a second plurality of images,

the second plurality of images being ranked based on an attribute associated with the selected particular set of rankings.

2. The method of claim **1**, further comprising:

generating the set of the rankings of the images.

3. The method of claim **2**, where, when generating the set of the rankings of the images, the method includes:

generating the set of the rankings of the images based on applying different attributes to each set of the rankings of the images.

4. The method of claim **1**, where, when selecting the particular set of the rankings, the method includes:

comparing an order of images of the first plurality of images with an order of images in each set of the rankings of the images; and

selecting, based on comparing the order of images of the first plurality of images with the order of images in each set of the rankings of the images, the particular set of the rankings.

5. The method of claim **1**, where the first plurality of images are grouped into the plurality of clusters based on receiving a query image.

6. The method of claim **5**, further comprising:

receiving another query image;

determining that the other query image is similar to the query image; and

ranking, based on determining that the other query image is similar to the query image, a plurality of images, associated with the other query image, based on the attribute associated with the selected particular set of rankings.

7. The method of claim **1**, where the attribute, associated with the selected particular set of rankings, corresponds to dimension information.

8. A system comprising:

one or more devices to:

generate, based on a first plurality of images grouped into a plurality of clusters, a ranking of the first plurality of images,

each cluster, of the plurality of clusters, including at least one of the first plurality of images, and

the ranking of the first plurality of images being based on a respective image attribute associated with each image, of the first plurality of images, in each cluster of the plurality of clusters;

compare the ranking with a set of rankings of images;

select, based on the comparing, a particular set of rankings from the set of the rankings of the images; and

provide, for presentation, a second plurality of images,

the second plurality of images being ranked based on an attribute associated with the selected particular set of rankings.

9. The system of claim **8**, where the one or more devices are further to:

generate the set of the rankings of the images.

10. The system of claim **9**, where the one or more devices, when generating the set of the rankings of the images, are further to:

generate the set of the rankings of the images based on applying different attributes to each set of the rankings of the images.

11. The system of claim **8**, where the one or more devices, when selecting the particular set of the rankings, are further to:

compare an order of images of the first plurality of images with an order of images in each set of the rankings of the images; and

select, based on comparing the order of images of the first plurality of images with the order of images in each set of the rankings of the images, the particular set of the rankings.

12. The system of claim **8**, where the first plurality of images are grouped into the plurality of clusters based on receiving a query image.

13. The system of claim **12**, where the one or more devices are further to:

receive another query image;

determine that the other query image is similar to the query image; and

rank, based on determining that the other query image is similar to the query image, a plurality of images, associated with the other query image, based on the attribute associated with the selected particular set of rankings.

14. The system of claim **8**, where the attribute, associated with the selected particular set of rankings, corresponds to dimension information.

15. A non-transitory computer-readable medium storing instructions, the instructions comprising:

one or more instructions which, when executed by at least one processor, cause the at least one processor to:

generate, based on a first plurality of images grouped into a plurality of clusters, a ranking of the first plurality of images,

each cluster, of the plurality of clusters, including at least one of the first plurality of images, and

the ranking of the first plurality of images being based on a respective image attribute associated with each image, of the first plurality of images, in each cluster of the plurality of clusters;

compare the ranking with a set of rankings of images;

select, based on the comparing, a particular set of rankings from the set of the rankings of the images; and

provide, for presentation, a second plurality of images, the second plurality of images being ranked based on an attribute associated with the selected particular set of rankings.

16. The non-transitory computer-readable medium of claim **15**, where the one or more instructions further include:

one or more instructions to generate the set of the rankings of the images.

17. The non-transitory computer-readable medium of claim **16**, where the one or more instructions to generate the set of the rankings of the images include:

one or more instructions to generate the set of the rankings of the images based on applying different attributes to each set of the rankings of the images.

18. The non-transitory computer-readable medium of claim **15**, where the one or more instructions to select the particular set of the rankings include:

one or more instructions to compare an order of images of the first plurality of images with an order of images in each set of the rankings of the images; and

one or more instructions to select, based on comparing the order of images of the first plurality of images with the order of images in each set of the rankings of the images, the particular set of the rankings.

19. The non-transitory computer-readable medium of claim **15**, where the first plurality of images are grouped into the plurality of clusters based on receiving a query image.

20. The non-transitory computer-readable medium of claim **19**, where the instructions further include:

one or more instructions to receive another query image;

one or more instructions to determine that the other query image is similar to the query image; and

one or more instructions to rank, based on determining that the other query image is similar to the query image, a plurality of images, associated with the other query image, based on the attribute associated with the selected particular set of rankings.

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